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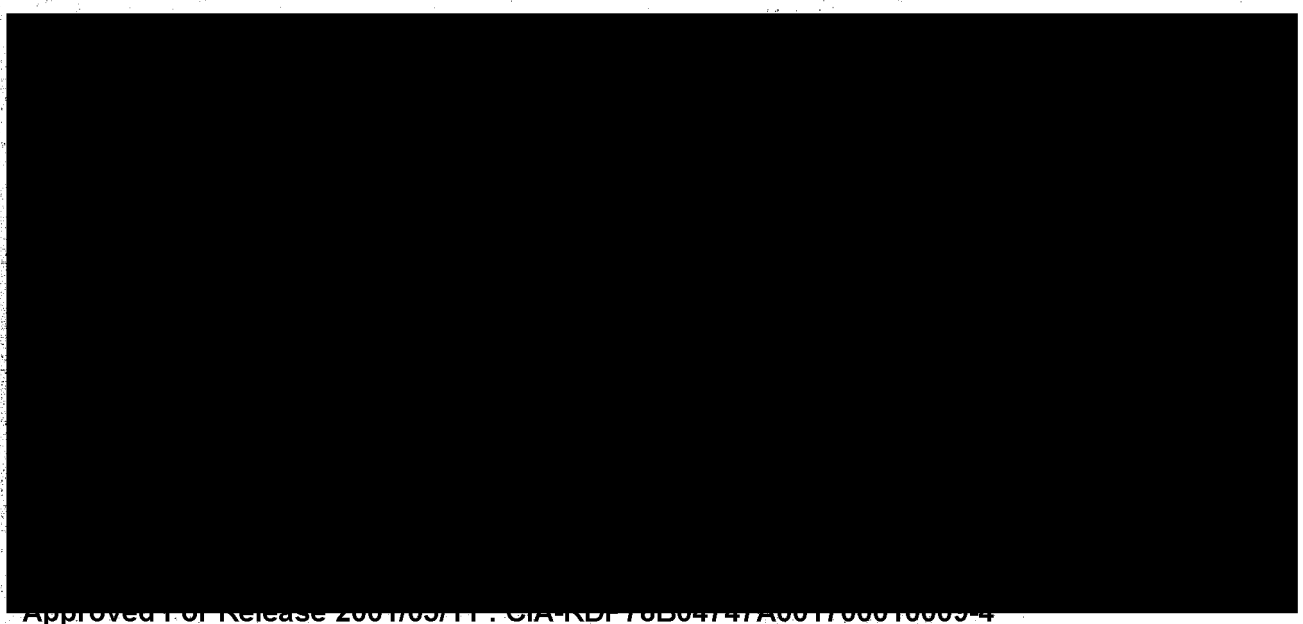

STATOTHR

[redacted] No. 7506-ECP-1

[redacted] STATINTL

DIRECT IMAGE VIEWER

ENGINEERING CHANGE PROPOSAL

STATOTHR

[redacted]

22 October 1964

STATOTHR

[redacted]

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1.0 SCOPE

The objective of this document is to set forth for evaluation STATOTHR by appropriate customer technical and contracting representatives [redacted] recommended engineering changes (Section 3.0) and related cost (Section 5.0) for the employment of an advanced light source and modified film positioning device in the experimental engineering model of the Direct Image Viewer. This unit is currently undergoing design and fabrication by [redacted] STATOTHR [redacted] STATOTHR

The purpose of the advanced light source is to provide for an increased light intensity source which can be made variable through the application of variable density wedges in the optical path, be capable of being cycled ON and OFF with selected changes in viewing magnification, and which will provide a minimum operator viewing illumination of 100 foot-lamberts.

The purpose of the modified film positioning device is to provide for an expanded X-Y viewer translation capability which will permit individual viewing of any image area over either a 70mm square or 4 x 5 inch film format at prescribed viewer magnifications. It further consists of an improved platen configuration suggested by the COTR.*

These technical changes were previously described in conjunction with [redacted] First Quarterly Project Report submitted to the appropriate customer representatives on 19 October 1964.

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* Contracting Officer's Technical Representative

2.0 BACKGROUND INFORMATION

Included in this section to assist the customer's technical and contractual personnel in the evaluation of this Engineering Change Proposal is appropriate project background information, where applicable, which applies to this submission. It is hoped that an early and favorable customer evaluation may be obtained on the two proposed engineering changes in order that technical delays may not occur in the development of the viewer. This assumes special importance in view of the customer's own efforts in the development of a substitute phase grating for the contracted development of a suitable diffraction grating.

The significant items and/or events which directly bear upon the proposed engineering changes are as follows:

STATOTHR Original Submission

[redacted] original proposal submission was accomplished during the week of 24 February 1964, at which time an [redacted] STATOTHR representative hand carried our technical and cost proposals for an "Experimental Engineering Model of a Direct Image Viewer" to the customer, and reviewed the nature of the submission with both customer technical and contracting representatives at that time.

The proposal was predicated upon the design and development of single (50X) magnification Direct Image Viewer covering a 70mm square film format with a ±1 inch film positioning capability to permit individual viewing of all areas of the film format. The customer's technical representative informed the [redacted] representative that an estimated 8 to 10 weeks would be required in processing the proposal. No outstanding technical or cost items existed at this time.

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Requirement for an Intermediate Magnification

Subsequent to the original submission, the customer's technical representative requested (on 6 March 1964) that STATOTHR [redacted] prepare an addendum to its original proposal on the addition of an intermediate viewing magnification capability (5-10X) to the Direct Image Viewer, and that the company be prepared to submit the addendum at the time of contract negotiation. The customer stated that the cost of the added magnification should be held to a minimum, and that it was their intention to contract for this item in conjunction with the basic viewer at the scheduled contract negotiations. It was further announced at this time that a new technical project officer (COTR) would be assigned to the project in the near future due to personnel reassignment, and the new COTR would be introduced to contractor personnel at the initial project technical kickoff meeting.

Contract Negotiation

The contract negotiations occurred on 26 May 1964 at the contractor's facility. Due to other commitments the COTR could not be present at the negotiations, and it was previously arranged that he would stand by at his office to resolve by telephone any technical questions which may arise during the course of the negotiations.

STATOTHR The Contracting Officer for the customer met with STATOTHR [redacted] representatives on the scheduled date and verified their intentions to include in the negotiations the addition of the intermediate magnification requirement. Since it had been decided that this item would be covered at this time, [redacted] STATOTHR [redacted] submitted a new total cost proposal which included the cost of both magnifications.

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The Contracting Office also made available to the company at this time a copy of the COTRs Research Objective document which described the customer's viewer requirements. This document and our previous proposal submission constituted the basis for the contract. [redacted] requested the opportunity to have the Research Objectives document reviewed prior to proceeding with the negotiations and upon completion of company review found it to be generally acceptable. The negotiations then continued. Several questionable items were discussed during the negotiations with COTR by phone and clarified. Again the COTR expressed the added desire that the 5 inch film format capability be added to the viewer's capability, in addition to the basic film format size of 70mm. In this regard, various technical points were discussed and it was agreed that the addition of the 5 inch film format requirement would be accomplished with no added increase in viewer translation capability (e.g. it would remain $\pm$ 1 inch). The form of the 5 inch viewed film would be a film chip mounted directly to the originally proposed 70mm platen arrangement. The 5 inch chip would thus be positioned over only a 70mm square area. With this agreement, the added capability for viewing the 5 inch film chips in the manner described was added into the contract during the contract negotiations with no related increase in cost.

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Initial Project Technical Kickoff Meeting

The contract provisions specified that shortly after receipt of contract a technical meeting would be held between the COTRs and [redacted] to resolve any remaining technical interface matters between contractor efforts, and to review with COTRs the project plan.

The meeting was held in [redacted] on 13 July 1964 with the new COTR being introduced and present. At the meeting [redacted] presented a project schedule, project specification, and also presented the COTR with copies of the subcontractor statements of work. A technical review of the viewer's configuration was held at this time. The results of the meeting were recorded per contract requirements and copies sent to all representatives.

The significant points or actions which came out of the meeting were:

1. Feasibility of an alternate optical configuration was to be investigated to minimize need for folding optics.
2. Selection of viewer wavelength was accomplished.
3. Requirement for an increased intensity light source was tentatively decided upon subject to completion of [redacted] optics design and a requirement was established that the minimum amount of illumination that would be available to a PI (open film gate) would be 100 foot/lamberts.
4. The COTR issued a statement regarding customer's phase grating efforts, and the added requirement for a formal technical meeting at [redacted] at the end of [redacted] Phase I.

5. [redacted] would propose upon an expanded X-Y translation capability and platen design modification to accommodate full frame 5 inch cut film.

Each of these items were to be examined and reported upon the COTR as to their desirability and impact upon existing contract provisions. The current status of these items are as follows:

Item 1 was investigated by [redacted] and [redacted] and reported upon to the COTR by letter on 26 August 1964.

Item 2 was selected at the 13 July meeting to be a central band of light concentrated at the 508.6mμ wavelength.

Item 3 was investigated between [redacted] and [redacted] recommendations were received on 8 September 1964. [redacted] then investigated the availability of higher intensity light sources than previously proposed and submits its recommendations herein.

Item 4 - a meeting was held at [redacted] on 24 September 1964 at which time a review was conducted of [redacted] diffraction grating development program, and approval was given for [redacted] to proceed with the initial grating fabrication trial of Phase II. Also, at this time [redacted] met with the COTR's and was informed of the status of the customer's phase grating development and its potential early availability. It became evident at this time, and from later discussions, that acceleration of the optical and mechanical portions of the Direct Image

Viewer development was desirable since the earlier availability of a suitable phase grating may result in the decision to reduce and/or cancel a portion of STATOTHR [redacted] effort. A planned acceleration of the mechanical and optical portions of the development was investigated, and it was determined that availability of glass precluded any reduction in the delivery of the optics, but that the mechanical portions of the viewer could be accelerated 1) as soon as optical installation data was available, and 2) as soon as a customer decision could be obtained regarding the proposed modifications to the expanded film positioning device and the higher intensity light source.

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Item 5 - [redacted] has completed a layout design of the modified X-Y translation device capable of providing full viewing coverage and examination of both 70mm and STATOTHR 4 x 5 inch film format sizes. [redacted] is proceeding with the detail design and fabrication of remaining areas of the viewer, and at the present time submits as an ECP its design approach to the expanded film positioning device.

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In keeping with the desirability for an accelerated development schedule for the basic viewer, [redacted] requests the appropriate customer review and approval at this time.

3.0 TECHNICAL JUSTIFICATION FOR PROPOSED ENGINEERING CHANGES

STATOTHR [redacted] submits for consideration under STATOTHR [redacted] at this time two proposed engineering changes to the Direct Image Viewer. The first change deals with the utilization of an improved water cooled 1000 watt high intensity Xenon light source in place of the air cooled Osram lamp previously proposed. The second change pertains to the modification of the original film positioning device (vacuum platen and X-Y translation mechanism) to provide for expanded vacuum platen hold down and X-Y translation capabilities to permit the operator to examine and evaluate imagery contained anywhere within a full 4 x 5 inch film format area at prescribed viewer magnifications.

The proposed engineering changes are presented below in summary form, and are further expanded upon in Section 4.0.

Light Source

STATOTHR Recently completed illumination calculations by STATOTHR [redacted] indicate that a 1000 watt Xenon arc lamp is required to produce the minimum required 100 foot lamberts of illuminance in the exit pupil plane for normal operator viewing. This value represents a three-fold increase over initial light intensity values utilized in earlier project estimates.

Since earlier project estimates could not anticipate the optical design characteristics of the viewer in sufficient depth to permit a proper light source selection until a preliminary design of the optical system was undertaken, initial estimates were then based upon previous breadboard results. Once the contract was received and the subcontractors were authorized to proceed. These initial estimates proved to be inadequate when a full and detailed analysis of the viewer's optical train was undertaken.

It became evident through discussions with our subcontractors and in our initial mechanical designs that an improved light source would be required of the type described which contained special cooling conditions to remove the excessive heat generated from their use, to conform with requirements contained with the customer's research objectives pertaining to film temperatures. To assist [redacted] in this matter, STATOTHR the customer agreed to make available to the project two copies of a "Study in Viewer Light Sources" they had performed. This information, when combined with other technical information resulted in the tentative selection and our present recommendation to use a water cooled light source to eliminate the above mentioned problems.

Since the use of such a light source represents a change in the basic viewer configuration and supporting installation characteristics, all of which occur at a significant increase in cost over the previous approach, an engineering change action is felt to be in order at this time. Presently two Xenon lamps of the 1000 watt capacity are required to operate in conjunction with the two different viewer magnifications. Each lamp operates independently from the other and will be illuminated only when a particular viewer magnification is in use to conserve on power and reduce film temperature conditioning problems.

Film Positioning

STATOTHR In [redacted] original proposal submission, it was proposed that an X-Y translation capability be added to the Direct Image Viewer in order to permit the operator to examine any image area of a 70 x 70mm film format at the 50X viewing magnification. This capability was recommended as being required since at any one time, the operator when viewing at the higher magnification would only observe an area 0.2 inch x 0.2 inch square.

STATOTHR [redacted] proposed to accomplish the required translation of ±1 inch in X and Y by the use of simple motor driven platen carriage assembly mounted to a slide rail. The carriage assembly was positioned through a motor driven lathe type machine screw in the X direction to provide the required transverse freedom from a control mounted on the front of the viewer. The Y motion was controlled through a motor controlled positioning cam to provide the necessary vertical travel. The entire film platen assembly and associated X and Y drives were mounted to the top of the carriage assembly which could be electrically indexed to one of two positions dependent upon which viewer magnification had been selected. The film itself was to be held by a vacuum to a grooved glass plate free of striations.

At the time of the initial contract technical review and kickoff meeting, the mechanical design configuration of the viewer was reviewed by technical representatives of the customer who felt that while the proposed design would suffice for the 70mm viewing case, they would like the viewer configuration altered to permit full inspection of a standard 4 x 5 inch film chip, and the platen design modified to incorporate film hold down provisions similar to techniques employed in other current viewing equipment utilized by their organization.

STATOTHR [redacted] agreed to undertake a technical evaluation of this suggested design change and to determine the added cost and technical changes required to achieve the desired expanded viewing coverage. At the conclusion of this evaluation, recommendations would be submitted to customer contracting and technical representatives for their evaluation and subsequent action.

STATOTHR [redacted] at the present time, has completed a preliminary design of the expanded film positioning device which permits the full attainment of the desired viewing capability and agrees that

this expanded capability should be incorporated into the present viewer design currently under contract.

It is felt that this action, if taken at this time, will produce a significant cost savings to the customer since it eliminates the necessity to redesign this area of the viewer in future models to achieve the required viewing capability. The alternate approach, of course, would be to proceed with the development of the more restrictive design viewing capability as set forth in the present contract, and view only a 70 x 70mm square area of the film format regardless of size of film chip being examined.

This means that in cases where it is desirable to view 4 x 5 inch film chips, that it will be necessary to have the individual operator interrupt his photo interpretation functions to gain access to the Direct Image Viewer filmgate mechanism to manually reposition the film in the platen to permit full evaluation and assessment of the imagery over its entire format. Repeated operations of this type are both time consuming and unwarranted. STATOTHR [redacted] believes that greater viewer utility will result from the addition of the expanded film positioning capability at this time, and further believes that the action if taken now will produce both a time savings and a cost savings in the production of future operational models.

A more detailed description of the new and expanded film positioning mechanism proposed and recommended for use in the Direct Image Viewer is included in Section 4.0.

4.0 ECP ENGINEERING CONSIDERATIONS AND TECHNICAL DESCRIPTION

4.1 Light Source

4.1.1 Review of Light Source Initially Proposed

At the time of our original proposal, the required light intensity was not fully known and estimates were used based upon previous results in its selection. Since a narrow portion of the spectrum between 500-550 mμ was required, an Osram lamp was considered. This type of lamp can be obtained with different emission gasses which provide various spectral lines in this portion of the spectrum. A variable power supply was also available as off the shelf equipment to provide the necessary power to operate the individual lamps. The lamp operated at low wattage and greatly simplified the cooling system.

4.1.2 Present Light Source Description

As previously mentioned, the detail illumination calculations recently performed indicate that an 800-1000 watt Xenon lamp is now required. In keeping with its responsibilities as prime contractor, [redacted] has spent time investigating lamp types, and reviewing the illumination calculations and condenser design.

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The results of company investigations finally narrowed down to the use of either a Xenon or a mercury arc lamp. These lamps come in many forms, two of which would be suitable for use in the viewer. These are the short arc and short tube type arc. The short arc lamp has a high brightness, as the electrode configuration concentrates all the light energy into an arc only a few millimeters in diameter. However, this lamp operates with a surface temperature of 700°C., and its use would require a high degree of forced air cooling to keep the

inside of the viewer cool due to the high amount of heat transmitted to the atmosphere. The short tube type arc produces a more extended arc about 7 x 12 mm in size. By virtue of its configuration it can be placed in a glass water jacket and water cooled with a flow of 1 gallon per minute. This cools the lamp to such an extent that a person may place his hand on the lamp while it is operating. Irrespective of air or water cooling, however, both lamps radiate sufficient infrared energy to surrounding components that viewer heating will still occur unless several procedures are utilized to reflect the infrared energy out of the viewer.

The current viewer design configuration is based upon the use of two lamps, one for each magnification. The lamps will be required to be placed approximately 9 inches apart. They will be alternately switched to full operation with selected changes in viewer magnification. In order to increase lamp life, however, the lamp not in use will be operating at a reduced current to maintain a partial arc. When the magnification is changed, it will receive full power and the other lamp will be reduced to the low current condition. The water cooling will flow through both lamps at all times.

The water cooling system would be contained in a separate enclosure with the power supply to eliminate the development of any possible vibrations.

When either type of arc lamp is varied over a reasonable intensity range, the arc size shrinks. The condenser design cannot accept this condition and still provide even illumination over the film plane and objective pupil.

Therefore, the intensity must be lowered by the insertion of a rotating varying density wedge in the optical path. A rotating wedge will be placed in each condenser system and interlocked so that the same intensity change will occur in each path. One control is used to perform this function regardless of which magnification is being used.

4.2 Film Positioning Mechanism

4.2.1 Initially Proposed Mechanism

The enclosed engineering drawing 7506L1 illustrates the original film positioning mechanism with the exception that the film holder as shown was to be replaced by a larger piece of glass with an etched groove to hold a 2 inch square of 70mm or 4 x 5 film flat rather than accept 70mm glass slides only. This mechanism uses three separate drive systems. A cam and a small gear motor provided the ±1 inch Y movement. A second small gear motor translates the carriage 9 inches to change from one optical path to the other for a change in viewer magnification. The X movement is accomplished through the use of a purchased lathe type sliding way and a larger gear motor. This mechanism will hold the X-Y position set at one magnification when the film was transferred to the other magnification and optical path. To view all portions of a 4 x 5 piece of film in normal operation, the operator is required to break the vacuum seal and manually reposition the film.

4.2.2 Present Proposed Film Positioning Mechanism

The enclosed engineering drawings are presented at a scale of 1:1 and show the difference in physical size between the two approaches to gain the increased viewing area. Upon inspection it can be seen that the film hold down and positioning functions are performed differently between the currently recommended approach and the previous design.

First, the entire film is held flat whether it is 4 x 5 or 70mm. This is accomplished by two interchangeable platens, each with a vacuum manifold which operates over the entire film area, rather than a single square groove. This new form of film hold down provides an accurate flat film plane with no air entrapment. The interchangeable film platens are removed from the machine for easy loading and can be re-inserted in the Y slide shown in drawing 7506L2. This Y slide is then driven over a total distance of 4 inches ($\pm$2 in.) by a ball screw and nut. The yoke, which supports this Y slide and Y drive motor, slides on the large ball bushings and rails for the X movement and translates for the required magnification change.

A long ball screw and nut is used to perform this operation. This dual function is provided by the drive package shown in drawing 7506L3. The smaller gear motor drives the yoke back and forth in X for the required $\pm$ 2 inches. When a change in magnification is made the duplex clutch is engaged and the higher speed motor translates the yoke 9 inches from one optical axis to the other, so that the same area of film is being viewed at either magnification. This is accomplished by the gear reduction and worm driven cam actuated microswitches. The gear reduction is chosen to insure that the travel of the cam from one microswitch to the other provides the 9 inch travel.

The yoke is supported both above and below the film chip to aid in maintaining the film in the image plane of the lenses. This operation is critical since the 50X lens has a very small depth of focus when operating at F1 and at a resolution in excess of 200 l/mm. Although the viewer will have the ability to permit viewer focusing of the lenses at the different magnifications, it is felt that a rigid platen mechanism is required to eliminate the necessity for performing frequent viewer focusing operations.

5.0 RELATED COSTS

This section includes a breakdown of the additional cost required for the proposed engineering changes covered by this submission. The costs are presented separately to facilitate their individual evaluation, and include the benefit of cost allowances resulting from previously contracted amounts for each of these items.

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